PC-rich and PE-rich *Synechococcus* sp. can occupy complementary habitats however, the differential responses of photic regimes of the lineages have not been studied sufficiently. Thus, this study focused on the reaction to photoperiods controlling photosynthesis and growth rate since understanding the temporal progression of growth phases is essential for predicting cyanobacterial activity and their impact on ecosystem dynamics.

We found that at the same cumulative diel PUR dose (µmol photons m−2d−1), both PE-rich and PC-rich strains of *Synechococcus* sp., grew the fastest under low light (> 300 µmol photons m−2s−1) and the longest photoperiod (24 h). This is particularly important in polar regions, where prolonged daylight hours coupled with nutrient-rich waters may promote growth of the *Synechococcus* populations. Moreover, in the optimal conditions (24 h of photoperiod and a peak PAR of 180 µmol photons m−2s−1), one of the PE-rich *Synechococcus* sp. of the Baltic origin, reached the highest chlorophyll-specific exponential growth rate (µ) of 4.5 d−1 (3.7 h doubling time) on record for cyanobacteria. PE-rich strains in the exponential phase of growth demonstrated high ability to modulate the PUR/PAR ratio that likely allowed this remarkable growth rate. Additionally, we presented for the first time, the consistent patterns of effective absorption cross section for PSII photochemistry (σPSII′; nm2 quanta−1) in PC-rich and PE-rich picocyanobacteria, versus increasing cumulative diel PAR doses, showing a photoprotective mechanism against excessive irradiation. Our results indicates that the PE-rich strains are stronger light-harvesting competitors, while the PC-rich strains may have lower N-quotients for their light capture system. In this study, we also calibrated the *JV*PSII estimator to absolute rates of the electron transport using parallel measures of oxygen evolution (µmolO2 L−1 s−1), captured simultaneously to the Fast Repetition Rate fluorometry (FRRf) measures, which which will finally allow/ or which is essential to compute/derive/estimate sth…(a sentence or two why this is important).